

CLAIMS

I/We claim:

- [c1] 1. A communication method in an OFDM (Orthogonal Frequency Division Multiplexing) system, the method comprising:
- adapting modulation schemes, coding rates, pilot patterns and training symbols, and power levels, wherein:
 - the adaptation process is performed in a transmitter; and
 - the adaptation process is based on channel state information;
 - generating, by the transmitter, a control information signal representing adaptation information, wherein the control information signal includes a single index value indicator that refers to adaptation details of a modulation scheme, coding, training pilots, and power levels;
 - transmitting the adapted signal and the control information signal by the transmitter, separately or jointly;
 - receiving the adapted signal and the control information signal by a receiver;
 - looking-up the adaptation details from a look-up table at the receiver using the index value, wherein:
 - the table includes multiple sets of adaptation schemes employed by the transmitter; and
 - number of pilot patterns associated with a particular combination of a modulation scheme and a coding rate is a function of how often the particular combination is used for transmission;
 - measuring channel state by the receiver, based on the received signals, wherein the measurements include: signal strength, average SINR (signal to interference plus noise ratio), variance in time, variance in frequency, variance in space, BER (bit error rate), FER (frame error rate), MSE (mean square error), or any combination thereof; and
 - forming probing sequences using the channel state measurements and/or computing channel quality information.

[c2] 2. The method of claim 1, wherein the channel quality information based on channel state measurements during the previous transmission is used by a transmitter to determine an adaptation scheme for the next transmission, or wherein for a retransmission the transmitter selects an adaptation scheme from one of the previous transmissions that is appropriate for the retransmission.

[c3] 3. The method of claim 1, wherein the channel state information for a particular user is periodically updated on a feedback channel even when there is no forward transmission targeted to that user and wherein a receiver measures channel state from a common broadcast transmission or data transmission targeted to other users.

[c4] 4. The method of claim 1, wherein the probing sequence is transmitted from a receiver to a transmitter using an overlay scheme in which the probing sequence is overlaid on data transmission and the transmitter estimates channel profile in the time and/or the frequency domains based on the received probing sequence.

[c5] 5. An adaptive wireless communication apparatus in a multi-carrier communication system for a multi-user multi-cell environment, the apparatus comprising:

 a receiver configured to:

 receive adjusted data signals and associated control information transmitted by a signal transmitter, wherein:

 adaptation processes of the transmitter adjust at least one signal attributes selected from the group of modulation scheme, coding rates, pilot patterns, training symbols, power levels, spatial processing schemes, modulation constellation arrangements, transmitter antenna techniques, and subchannel configurations;

 the adaptation processes are based on transmission channel quality information (CQI) or channel

condition measurements fed back to the transmitter by the receiver; and

the control information includes an indicator that refers to a specific set of adaptation processes known to both the receiver and the transmitter;

measure channel conditions based on the received signals;

compute CQI based on measured channel conditions, for use by the adaptation processes to determine schemes for transmission of subsequent signals and associated control information; and

feed back channel measurements, CQI, or both, to the signal transmitter, wherein the channel measurements and the CQI carry information about: received signal strength, average SINR (signal to interference plus noise ratio), variance in time, variance in frequency, variance in space, BER (bit error rate), FER (frame error rate), or MSE (mean square error), or any combination thereof.

[c6] 6. The apparatus of claim 5, wherein the CQI for a particular receiver is periodically updated, even when there are no signals targeted to that receiver, by measuring the channel conditions from common broadcast signals or data signals targeted to other receivers.

[c7] 7. The apparatus of claim 5, wherein during the feedback of the CQI, bits with higher significance in CQI index are protected with stronger error protection codes.

[c8] 8. An adaptive wireless communication apparatus for network optimization in a multi-carrier communication system, the apparatus comprising:
a transmitter configured to:

adapt and transmit signals on multiple subchannels, wherein a modulation scheme, coding, training pilots, and power levels of the signals are all adjusted by adaptation

processes that respond to transmission channel quality information (CQI) or channel condition measurements that are acquired by or made available to the transmitter; transmit control information signals comprising information regarding the adaptation; and the transmitter is further configured so that:

- the adaptation processes are user-based or subchannel-based;
- the CQI is user-based or subchannel-based; and
- the adaptation processes and CQI can change over time and differ from one time slot to another.

[c9] 9. The apparatus of claim 8, wherein the multi-carrier communication system is an OFDM (Orthogonal Frequency Division Multiplexing) system, and wherein the adaptation comprises adjusting modulation scheme, coding rates, pilot patterns, training symbols, power levels, spatial processing schemes, modulation constellation arrangements, transmitter antenna techniques, subchannel configurations, or any combination thereof.

[c10] 10. The apparatus of claim 8, wherein the transmitter is a part of a base station, a mobile station, or both.

[c11] 11. The apparatus of claim 8, wherein the adaptation processes:

- adjust constellation mapping during transmission and retransmission in an automatic repeat request (ARQ) process; and
- determine a multiple-antenna technique, among available techniques, for transmission.

[c12] 12. The apparatus of claim 8, wherein the subchannel configuration is adjusted according to deployment scenarios and is broadcast to all users.

- [c13] 13. A multi-carrier communication system, comprising:
multiple transmitters configured to transmit data and associated modification information processed using channel measurements or channel quality information (CQI) computed from channel measurements;
multiple receivers configured to receive the data and the modification information; and
a configuration wherein:
the modification information, which includes modification of modulation schemes, coding specifics, training pilots, and power levels, is transmitted by an index value that identifies an explicit set of modulations known to the transmitter and to the receiver; and
the channel measurements and the CQI reflect received signal strength, average SINR (signal to interference plus noise ratio), variance in time, variance in frequency, variance in space, BER (bit error rate), FER (frame error rate), MSE (mean square error), or any combination thereof.
- [c14] 14. The system of claim 13, wherein the transmitters, the receivers, or both use predictive algorithms to predict current or future channel conditions based on previous channel conditions, and wherein the output of the predictive algorithms is used to select a scheme for current transmission.
- [c15] 15. The system of claim 13, wherein transmission of the channel measurements from a receiver to a transmitter employs an overlay scheme in which channel measurements are overlaid on data traffic without having negative impact on data transmission performance, and wherein the transmitter estimates channel profile in the time and/or the frequency domains based on the received channel measurements.
- [c16] 16. The system of claim 13, wherein source coding compresses the modification information or the CQI, and error correction coding provides error protection for the compressed modification information or the CQI.

[c17] 17. A multi-transmitter multi-receiver multi-carrier communication network, comprising:

means for adjusting at least one signal attributes selected from the group of modulation scheme, coding rates, pilot patterns, training symbols, power levels, spatial processing schemes, modulation constellation arrangements, transmitter antenna techniques, and subchannel configurations, at each transmission period, based on transmission channel condition information sent back by a receiver means of prior signals;

means for generating control information signal comprising adjustment information;

means for indexing the adjustment information included in the control signal;

means for transmitting an adjusted signal and the associated control information signal on a single channel or on separate channels;

means for receiving an adjusted signal and the associated control information signal;

means for looking-up the adjustment details of the adjusted signal using an index value;

means for measuring channel conditions based on the received adjusted and associated control information signals;

means for computing channel quality information by utilizing the received adjusted and associated control information signals; and

means for sending back, to a transmitter, the channel quality information, measured channel conditions, or both.

[c18] 18. The network of claim 17, wherein the transmitter means and the receiver means are part of a base station, a mobile station, or both.

[c19] 19. A multi-user communication method, comprising:

measuring transmission channel conditions;

adapting at least modulation scheme, coding specifics, training-pilot particulars, and power levels for at least some transmission periods, based on the measured channel conditions;

transmitting the adapted signal; and
transmitting adaptation information by transmitting an indicator, wherein the indicator signifies a specific set of adaptations selected from multiple sets of adaptations known to at least one receiver.

[c20] 20. The method of claim 19, wherein the channel condition information is sent back by a receiver based on previously received adjusted and associated control information signals.

[c21] 21. The method of claim 19, wherein the number of different pilot patterns associated with a particular combination of a modulation scheme and a code rate is directly related to the percentage of times the particular combination is used for transmission.